

# Department of Plastic and Hand Surgery

## Chair of Plastic and Hand Surgery

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### Director

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### Research focus

- Biofabrication (SFB TRR225)
- Tissue engineering
- Interaction of regenerative strategies and tumor progression
- New imaging techniques in reconstructive surgery
- Clinical experimental research
- Clinical studies

### Structure of the Department

Professorship: 1

Personnel: 29

- Doctors (of Medicine): 17
- Scientists: 7 (thereof funded externally: 7)
- Graduate students: 60

### Clinical focus areas

- Reconstructive microsurgery
- Esthetic surgery
- Burn surgery
- Breast surgery
- Hand surgery
- Body contouring
- Lymphedema/lipedema
- Laser
- Hyperhidrosis

### Research

Research interests of the Department of Plastic and Hand Surgery are the engineering of bioartificial tissue, tumor biology as well as clinical experimental research and clinical retrospective studies.

### Biofabrication (SFB TRR225)

PI: Prof. Dr. R.E. Horch<sup>1,2</sup>, Prof. Dr. A. Arkudas<sup>1,2</sup>, PD Dr. A. Kengelbach-Weigand<sup>2</sup>, Dr. D. Steiner<sup>1</sup>

- 1) Biofabrication of cellularized and AV loop vascularized tissue containers for the transplantation of drug-producing cells  
This DFG funded project (SFB TRR225) targets the generation of a transplantable therapeutic tissue container for the treatment of autoimmune diseases or cancer
- 2) Using biofabrication, a 3D tumor model will

be developed, serving for the investigation of different aspects of tumor progression in a controlled manner both *in vitro* and in the vascularized *in vivo* AV loop model. This project is DFG funded (SFB TRR 225)

### Tissue engineering

PI: Prof. Dr. R.E. Horch<sup>1,11</sup>, Prof. Dr. A. Arkudas<sup>1,10</sup>, PD Dr. A. Kengelbach-Weigand<sup>7,8,11</sup>, Dr. D. Steiner<sup>2,3</sup>, Dr. A. Cai<sup>4,6</sup>, Dr. M. Hessenauer<sup>4</sup>, Dr. W. Müller-Seubert<sup>5,9,10</sup>

- 1) Tissue engineering of skeletal muscle  
The final aim of this project is the generation of axially vascularized, innervated skeletal muscle tissue
- 2) Tissue engineering of axially vascularized bone in a small animal model  
The aim of this study is to generate axially vascularized bioartificial bone tissue using bioactive matrices in combination with endothelial cells (EC) and adipose derived stem cells (ADSC).
- 3) Investigation of the specific cell-cell interactions between ADSC and EC concerning osteogenic differentiation
- 4) Intravital microscopy in the AV loop model to understand the mechanisms of de novo tissue formation in the AV loop model, we developed a suitable chamber model which allows intravital microscopic evaluation
- 5) Ischemic tolerance of different tissues  
By using the model of rat hindlimb amputation, extracorporeal perfusion, and replantation, we analyze and try to prolong the critical ischemia time of different tissues
- 6) Transplantation of whole muscle constructs in a novel rat model  
A skeletal muscle is transplanted into a rat in an isolation chamber. Perfusion and functional analyses of the isolated muscle will be conducted
- 7) Differences in functional cell properties of ADSC affected by patient factors
- 8) Skin tissue engineering by the use of ADSC  
Current treatment options for chronic wounds will be optimized using growth factors and ADSC
- 9) Influence of irradiation on perfusion of random pattern flaps
- 10) Influence of stem cells on irradiated flaps  
This project measures the influence of topically applied stem cells on perfusion of irradiated random pattern flaps
- 11) Therapeutic strategies for the treatment of irradiated skin

### Interaction of regenerative strategies and tumor progression

PI: Prof. Dr. R.E. Horch<sup>1,7</sup>, Prof. Dr. A. Arkudas<sup>5,7</sup>, PD Dr. A. Kengelbach-Weigand<sup>1,7</sup>, Dr. T. Hauck<sup>5,7</sup>

- 1) Effects of tumors on a developing blood vessel network  
The goal of the project is the characterization of the influence of tumor cells on the development of a blood vessel network and the role of endothelial progenitor cells (EPC) in tumor

associated angiogenesis

- 2) Tumor angiogenesis and vasculogenesis in breast cancer

This study investigates the effect of mammary carcinoma cells on the angiogenic properties of EPC

- 3) Paracrine and cell-cell interaction of ADSC and mammary epithelial cells in the focus of development of breast cancer

This study evaluates the influence of ADSC on the behavior of cells in the breast and breast cancer tissue

- 4) Significance of tumor-associated fat stem cells in breast cancer progression

The surrounding adipose tissue of mammary carcinomas is probably changed by the influence of the tumor and may play a role in tumor progression. This will be investigated by analyzing stem cells from tumor-associated adipose tissue compared to stem cells from healthy adipose tissue

- 5) Establishment of a novel *in vivo* tumor model for breast cancer

This study aims to develop an *in vivo* 3D tumor model in which individual aspects of tumor progression and tumor therapy can be examined in a controlled manner

- 6) The autotaxin-LPA axis in breast cancer

This *in vitro* study evaluates the interplay of LPA, Autotaxin, adipose tissue and different breast cancer subtypes and the effect of radiotherapy on ATX-LPA signaling in breast cancer

- 7) The effect of irradiation on lipotransfer and breast cancer

This study investigates the oncological safety of lipotransfer into irradiated mammary tissue based on *in vitro* experiments with human cell lines

### New imaging techniques in reconstructive surgery

PI: Prof. Dr. R.E. Horch<sup>1,6</sup>, Prof. Dr. A. Arkudas<sup>2,5,6</sup>, PD Dr. I. Ludolph<sup>1,4</sup>, Dr. T. Hauck<sup>1</sup>

- 1) Three dimensional perforator mapping by Cinematic rendering

The aim of this study is to assess the clinical value of Cinematic Rendering in abdominal-based autologous breast reconstruction

- 2) Intraoperative fluorescence imaging of tissue perfusion in free flap transplantation using the SPY Elite® system

To improve the knowledge of tissue perfusion in free tissue transfer and free flap autonomization in the long term follow-up, intraoperative fluorescence imaging of tissue perfusion using a laser camera was performed

- 3) Comparison of thermography, hyperspectral analysis and ICG-angiography in the perfusion analysis of free flaps for autologous breast reconstruction

- 4) Intraoperative perfusion of free flaps from the abdomen for autologous breast reconstruction is assessed by using thermography, hyperspectral analysis and ICG-angiography

- 5) ICG-angiography for analysis of the zonal perfusion of free flaps from the abdomen for autologous breast reconstruction

By using ICG-angiography intraoperatively, the zonal perfusion of DIEP/ms-TRAM flaps is analyzed to gain further insight in the vascular anatomy and the perforasome theory

- 6) Impact of CT angiography on perforator mapping in autologous breast reconstruction
- 7) Perfusion analysis of myocutaneous flaps using ICG-angiography

#### Clinical experimental research

PI: Prof. Dr. R.E. Horch<sup>1-12</sup>, Prof. Dr. A. Arkudas<sup>1-3, 4, 6, 7, 12</sup>, PD Dr. I. Ludolph<sup>5, 8-11</sup>, Dr. A. Cai<sup>6</sup>, Dr. J. Grüner<sup>6, 11</sup>, Dr. A. Geierlehner<sup>1-3, 8</sup>, Dr. D. Steiner<sup>3</sup>

- 1) Assessment of blood flow characteristics in free flaps using Transit Time Flowmetry and microvascular angiography
  - 2) Flow measurement of the arterial and venous vessels of free and local flaps
  - 3) Blood flow measurement and proteome profiling of arteriovenous loops in free tissue transfer procedures
  - 4) Flow coupler efficacy in DIEP/ms-TRAM flaps for autologous breast reconstruction
  - 5) Impact of negative pressure wound therapy on skin perfusion
  - 6) Perfusion analysis of the skin using thermography and hyperspectral analysis following negative pressure wound therapy in healthy volunteers
  - 7) Prospective analysis of grip force in common hand conditions
- This prospective study evaluates the effect of a surgical procedure on hand grip force
- 8) Evaluation of carpal instability regarding scapholunate ligament injuries
- The aim of this study is to evaluate wrist mobility between carpal bones using CT analysis in order to invent new strategies to treat ligament injuries
- 9) Proteom profiling and immunohistochemical analysis of chronic wound during negative pressure wound therapy
  - 10) Analysis of skin elasticity before and after body countering procedures
  - 11) Influence of different silicone surface textures to prevent capsular fibrosis of the breast Capsular fibrosis represents a significant complication following implantation of silicone breast implants, necessitating further surgical intervention. Experimental in vitro studies are conducted to investigate diverse silicone surface textures and their influence on capsular fibrosis
  - 12) Molecular and histological investigations in periimplant mamma tissue
  - 13) Comparison of shoulder function of patients after muscle-sparing and complete latissimus dorsi harvest

The aim of this study is the evaluation of the relevance of muscle-sparing latissimus dorsi flap harvesting regarding shoulder functionality and

strength

#### Clinical studies

PI: Prof. Dr. R.E. Horch<sup>1-10</sup>, Prof. Dr. A. Arkudas<sup>1-3, 5</sup>, PD Dr. I. Ludolph<sup>2-6</sup>, Dr. W. Müller-Seubert<sup>8, 9</sup>, Dr. T. Hauck<sup>10</sup>, Dr. A. Cai<sup>3</sup>, Dr. A. Geierlehner<sup>5, 6</sup>, Dr. M. Stumpfe<sup>2</sup>, Dr. J. Grüner<sup>4</sup>, N. Fritz<sup>7</sup>

- 1) Technical innovations to reduce complications rates in free DIEP/ms-TRAM flaps

This retrospective study investigates the application of ICG-angiography, coupler anastomoses, preoperative perforator mapping with CTA, and mesh implantation at the donor site and their influence on complication rates.

- 2) Investigation of laboratory results in body countering surgery

Analysis of laboratory results and their impact on the postoperative course in body contouring surgery following massive weight loss

- 3) Analysis of quality of life and physical activity of postbariatric patients

The impact of body contouring procedures on quality of life and physical activity of patients that have undergone massive weight loss is retrospectively analyzed

- 4) Negative pressure wound therapy (NPWT) in breast implant associated infections

In the study the effect of NPWT on reducing the bacterial load and number in breast implant associated infections is analyzed

- 5) Limb salvage procedure in immune-compromised patients with therapy resistant leg ulcers – The value of ultra-radical debridement and instillation negative pressure wound therapy

- 6) Negative pressure wound therapy in the treatment of chronic leg ulcers

Investigation of chronic wounds of the lower leg with regard to the use of negative pressure wound therapy and the defect reconstruction

- 7) Influence of k-wire transfixation on the proximalization of the first metacarpal after resection suspension interposition arthroplasty

- 8) Retrospective analysis of surgical therapy in cubital tunnel syndrome

In this study, outcomes and complications after partial medial epicondylectomy in cubital tunnel syndrome are analyzed

- 9) Dupuytren's disease

Retrospective analysis of severe, advanced and relapsing Dupuytren's disease with actual evaluation by DASH-Score. Evaluation of the Erlangen distraction device

- 10) The role of the pedicled gastrocnemius flap in covering defects in the knee and proximal lower leg area

This retrospective study evaluates the outcome of pedicled gastrocnemius flaps. The results are evaluated using a self-created and a validated

questionnaire (Knee Outcome Survey)

#### Teaching

With compulsory and elective subjects, the Department of Plastic and Hand Surgery is involved in the curriculum-based teaching in medicine. In this context, besides a preclinical conjoint course together with the Institute of Anatomy, a microsurgical suture course is offered besides theoretical courses.

Furthermore, MD and PhD theses are supervised.

#### Selected publications

A. Kengelbach-Weigand, K. Tasbihi, P.L. Strissel, R. Schmid, J.M. Marques, J.P. Beier, M.W. Beckmann, R. Strick, R.E. Horch, A.M. Boos, Plasticity of patient-matched normal mammary epithelial cells is dependent on autologous adipose-derived stem cells, *Sci Rep* 9(1) (2019) 10722.

R. Schmid, S.K. Schmidt, J. Hazur, R. Detsch, E. Maurer, A.R. Boccaccini, J. Hauptstein, J. Tessmar, T. Blunk, S. Schrufer, D.W. Schubert, R.E. Horch, A.K. Bosserhoff, A. Arkudas, A. Kengelbach-Weigand, Comparison of Hydrogels for the Development of Well-Defined 3D Cancer Models of Breast Cancer and Melanoma, *Cancers* (Basel) 12(8) (2020).

R.E. Horch, I. Ludolph, A. Cai, K. Weber, R. Grutzmann, A. Arkudas, Interdisciplinary Surgical Approaches in Vaginal and Perineal Reconstruction of Advanced Rectal and Anal Female Cancer Patients, *Front Oncol* 10 (2020) 719.

D. Steiner, R.E. Horch, I. Ludolph, M. Schmitz, J.P. Beier, A. Arkudas, Interdisciplinary Treatment of Breast Cancer After Mastectomy With Autologous Breast Reconstruction Using Abdominal Free Flaps in a University Teaching Hospital-A Standardized and Safe Procedure, *Front Oncol* 10 (2020) 177.

A. Geierlehner, R.E. Horch, W. Müller-Seubert, A. Arkudas, I. Ludolph, Limb salvage procedure in immunocompromised patients with therapy-resistant leg ulcers-The value of ultra-radical debridement and instillation negative-pressure wound therapy, *Int Wound J* 17(5) (2020) 1496-1507.

#### International cooperation

Prof. S. Jiaming, Tongji Medical College, Huazhong University of Science and Technology, Wuhan: China